



Atomic Layer Etching Pitch Splitting (APS™) for Nanoimprint Lithography Combining Simplicity, Precision, and Sustainability

Reza Jafari Jam*¹, Robin Athle¹, Yoana Ilarionova¹, Fabian Mathias Veid¹, Alfred Ahlström Andersson¹, Svetlana Ivanova¹, Kishwar Sultana¹, Ken-ichiro Mori², Makoto Ogusu², Dmitry Suyatin¹, Jonas Sundqvist¹, [Amin Karimi](#)*¹

1. AlixLabs AB, Ole Römers Väg 1, Entrance H, 223 63 Lund, Sweden

2. Canon Inc., 20-2, Kiyohara-Kogyodanchi, Utsunomiya-shi, Tochigi 321-3292 Japan



AlixLabs AB

- Start Up & Spin-Off from Lund University
- Founded in Lund, Sweden 2019



Managed by experts in ALE and Semiconductor Equipment Industry



Jonas Sundqvist, PhD

CEO & Co-founder

- Developed ALD and CVD processes since 1999
- Over >25 years' experience in semiconductor manufacturing
- Passionate entrepreneur who delivers on promises
- Strong network in semiconductor market



Peo Hansson

Advisor Semi Equipment



Amin Karimi, PhD

CTO & Co-founder

- Driven to bridge fundamental research and industrial semiconductor applications
- Proven track record in leading R&D projects
- Expert in semiconductor devices, Nanofabrication and materials



Garry Miner

Advisor Semi Equipment



Dmitry Suyatin, PhD

CSO & Co-founder

- Over 15 years of experience in advanced processing of nanostructures
- Author of more than 30 publications
- Well-known ALE expert in ecosystem



Robert Cadman,

Advisor Business Development



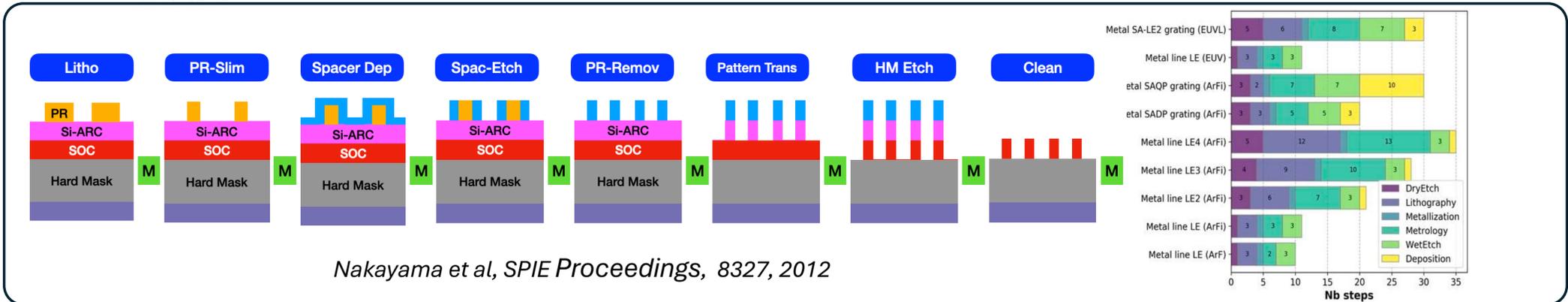
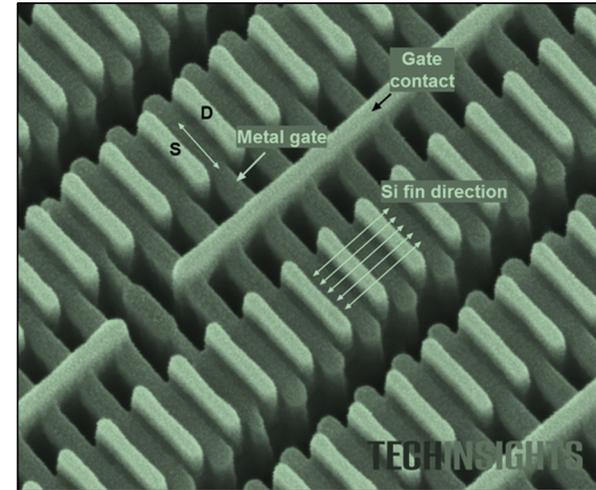
Per-Anders Eriksson

Deputy CEO and COO

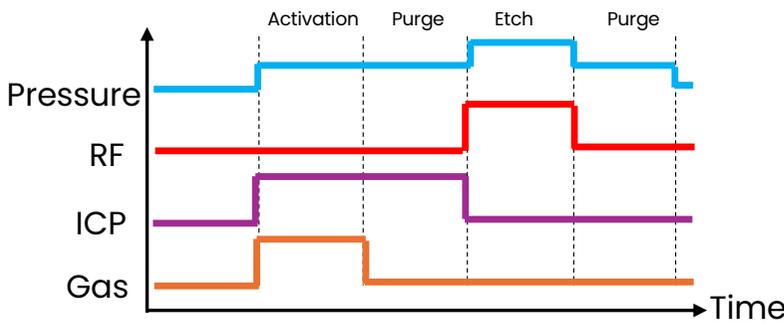
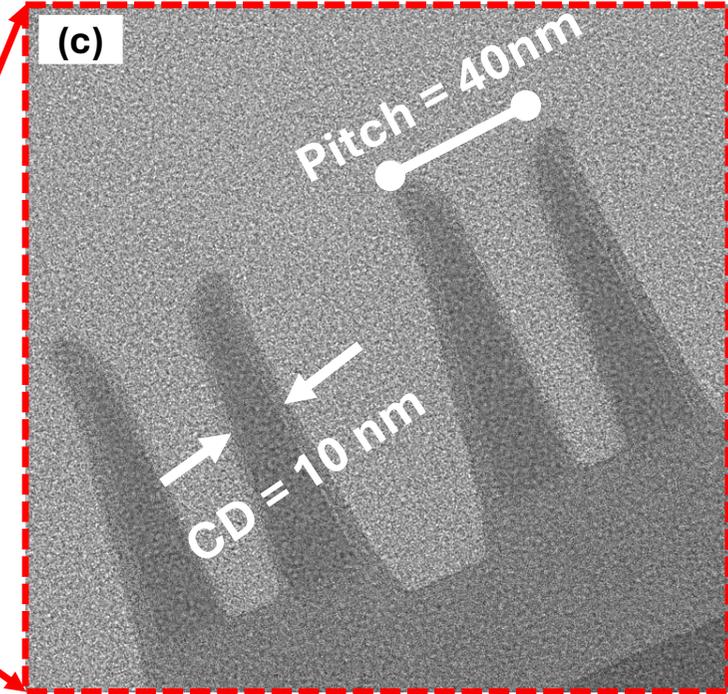
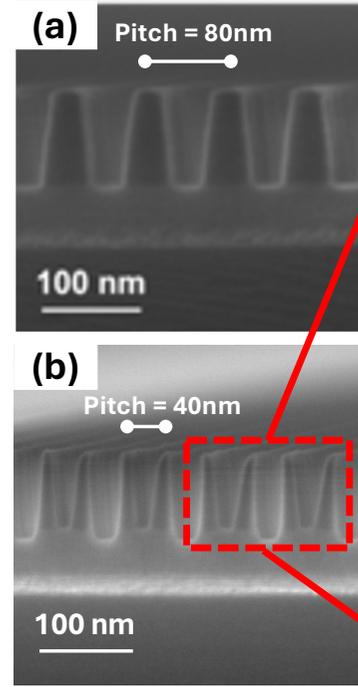
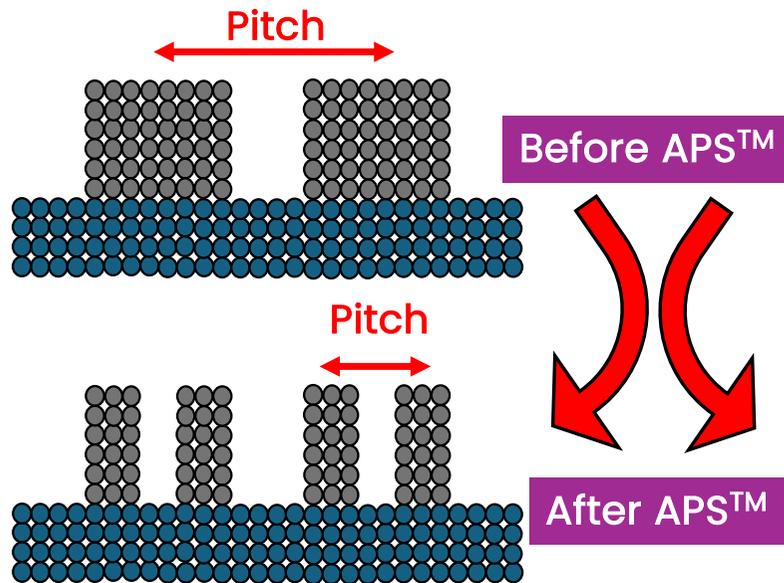
- Business Development
- Semiconductor Equipment industry



Dense Line Patterning as a Key Enabler of Moore's Law



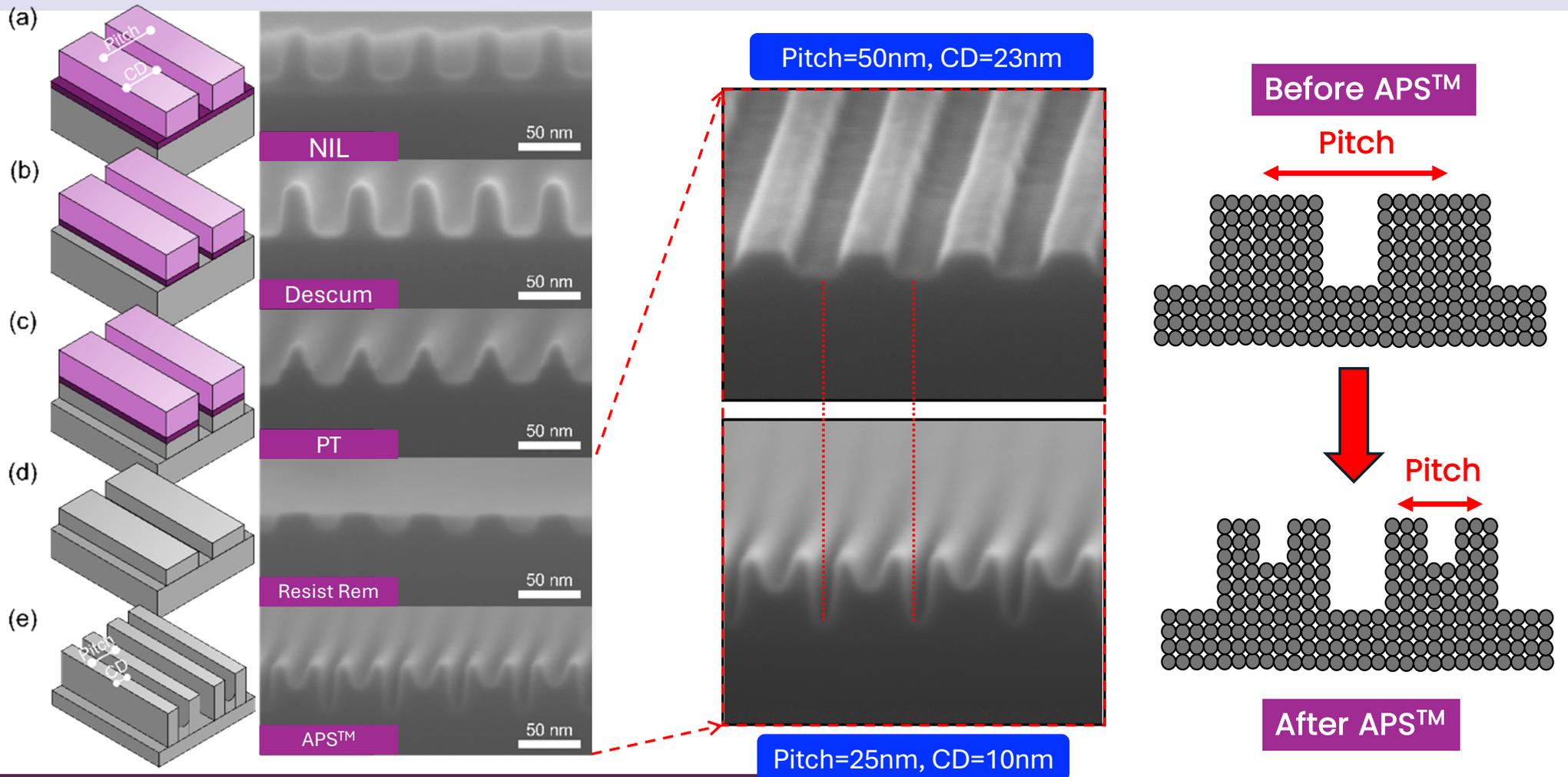
Atomic Layer Etching Pitch Splitting (APS™)



APS™ simplifies multi-patterning with a single-step process, reducing cost, complexity, and environmental impact compared to SADP, which requires multiple deposition and etching steps. APS™ enables higher yield, lower CAPEX/OPEX, and scalability to sub-2nm nodes.

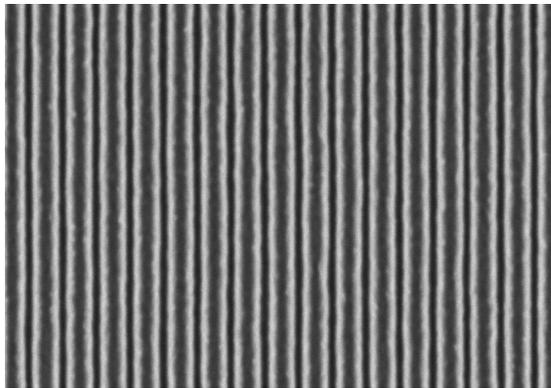
Proc. SPIE 13429, 2025 US Patent 10,930,515
US Patent 12,456,622 US Patent App. 19/194,777

APS for Nano Imprint Lithography on Bulk Silicon



APS™ in Bulk Silicon vs Low and high NA EUVL in Resist

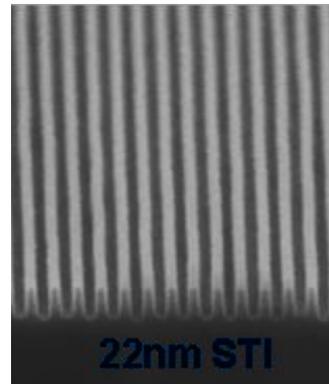
NIL + APS



CD	10 nm
Half Pitch	12.5 nm
LWR	2.2 nm
Material	Si

This work

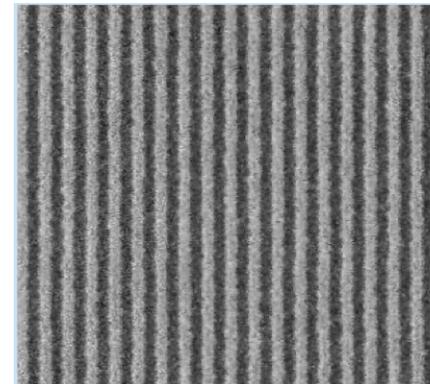
ArFi + SADP



CD	20 nm
Half Pitch	22 nm
LWR	2.5 nm
Material	Si

Proc. of SPIE, 69244E-12008

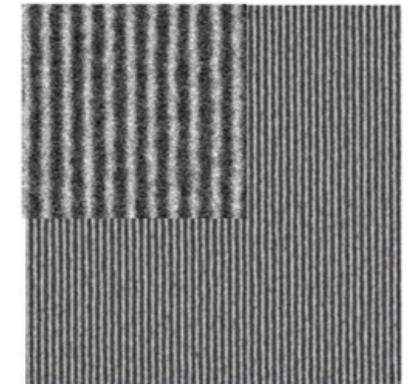
Low NA EUVL



CD	12.7 nm
Half Pitch	12 nm
LWR	1.7 nm
Material	Resist

EUVL Symposium, 11854-11 2021

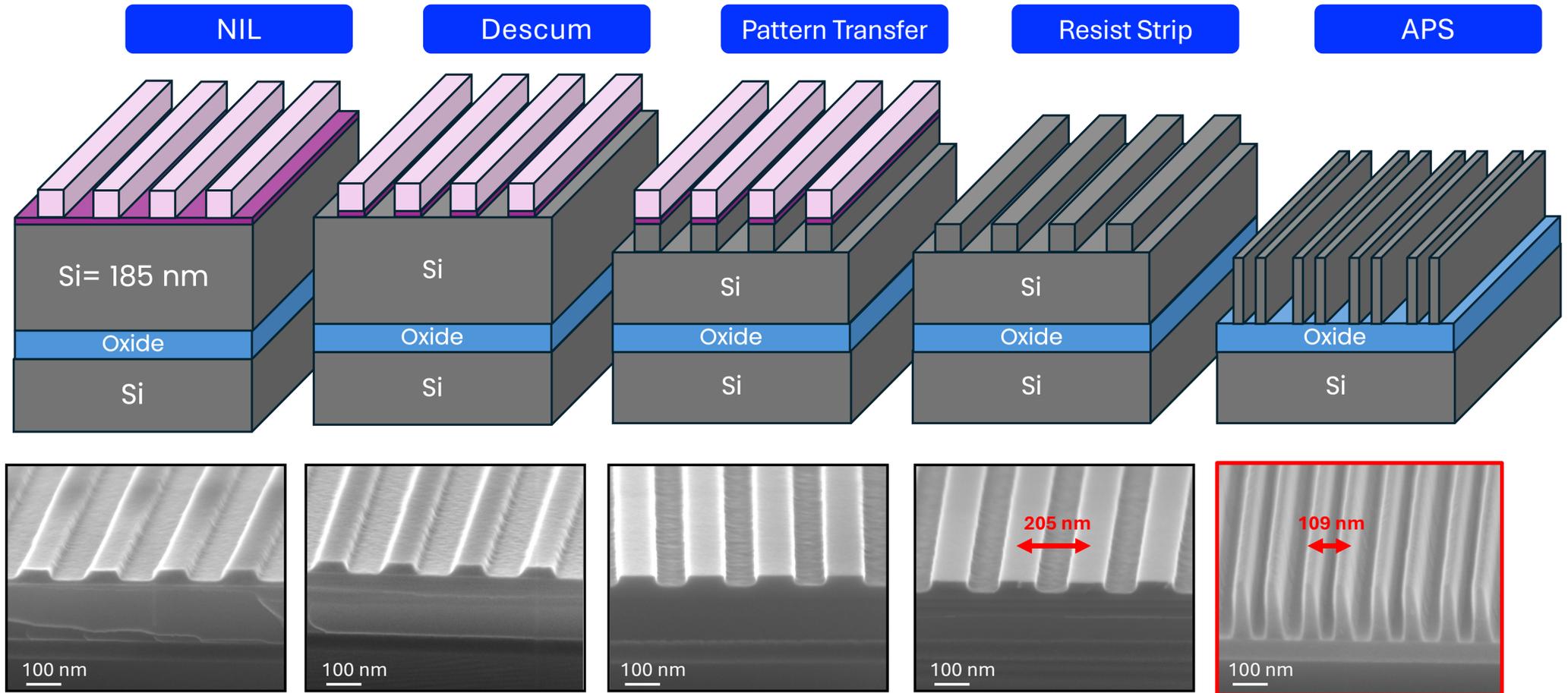
High NA EUVL



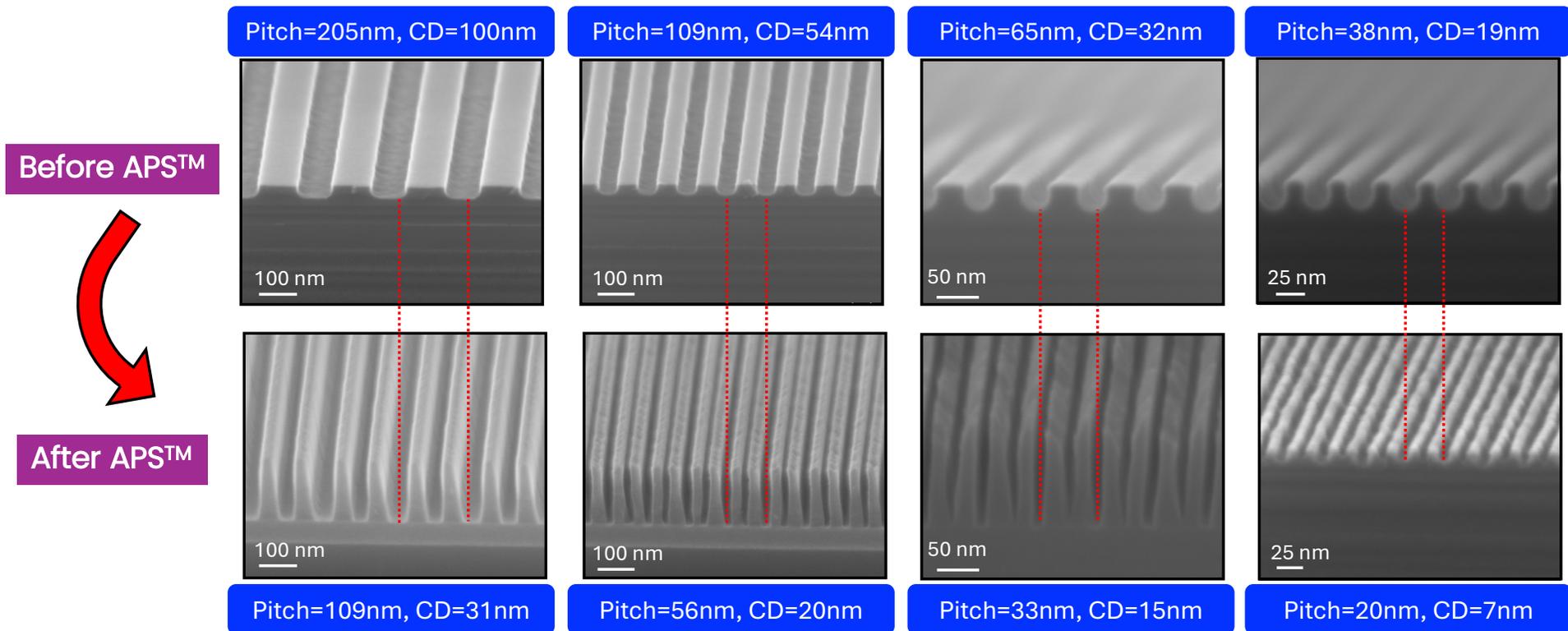
CD	6.6 nm
Half Pitch	8 nm
LWR	2.37 nm
Material	Resist

Source: Imec

Atomic Layer Pitch Splitting (APS™) on NIL-Defined SOI Wafer



Atomic Layer Pitch Splitting (APSTTM) on NIL-Defined SOI Wafer

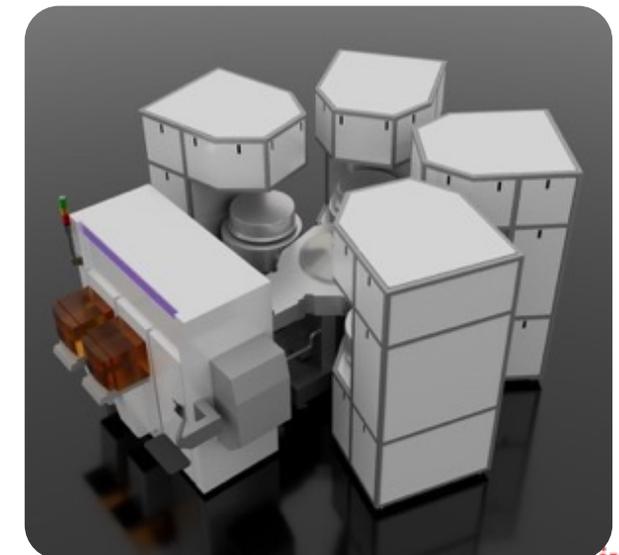


300mm tools for APS™ – Beta tool in manufacturing A fully automated wafer processing cluster for Fabs

AlixLabs Clean Room, Lund HQ



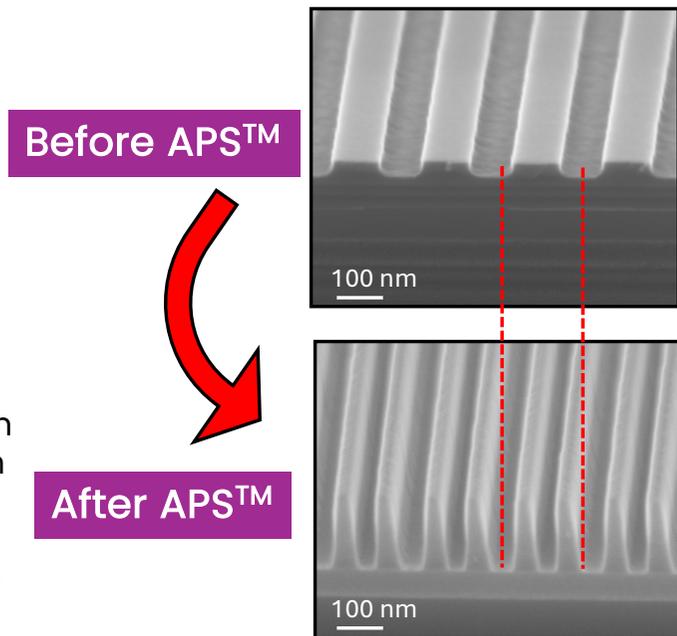
AlixLabs APSTM System
Coming Q4, 2026



- Alpha APSTM tool manufactured and operational in the AlixLabs Cleanroom in Lund, Sweden
- First of a kind 300 mm APSTM tool

Conclusion

- Atomic Layer Pitch Splitting (APS™) can serve as a strong complement to nanoimprint lithography (NIL) to extend resolution for dense line patterning.
- Silicon line structures with a critical dimension (CD) of 10 nm, half-pitch of 12.5 nm, and line-width roughness (LWR) of 2.2 nm were achieved, comparable to EUV lithography (EUVL) resist performance.
- On SOI wafers patterned by NIL, the application of APS™ demonstrated a clear etch stop on the buried oxide surface.
- APS™ can be considered an alternative to multiple patterning techniques such as SADP, SAQP, and LELE, offering potential benefits in cost reduction, resolution extension, and improved sustainability.
- APS™ improves sustainability by reducing the number of lithography and etch steps, lowering material consumption, energy use, and overall process complexity compared to conventional multiple-patterning flows.



Self-Aligned Quadruple Patterning Made Simple - Extending the Applications of Atomic Layer Etch-induced Pitch Splitting (APS™)



Let's get ahead

alixlabs.com

amin@alixlabs.com